WHAT IS CLAIMED IS:

1. A microfluidic structure comprising:

an underlying substrate;

a first elastomer layer overlying the substrate, the first elastomer layer bearing in a bottom surface a first recess; and

a second elastomer layer overlying the first elastomer layer, the second elastomer layer bearing in a bottom surface a second recess having an arched ceiling; and

a membrane portion of the first elastomer layer defined between the first recess and the second recess, the membrane portion deflectable upward into the second recess to conform with and seal against the arched ceiling.

2. The structure of claim 2 wherein the second elastomer layer is formed by curing an elastomer material against a nonelastomer mold bearing a convex feature.

3. The structure of claim 2 wherein the first recess comprises a control channel and the second recess comprises a flow channel.

4. The structure of claim 2 wherein the membrane portion is deflectable into the second recess in response to an elevated pressure within the first recess.

5. A microfluidic structure comprising:

an underlying substrate;

a first elastomer layer overlying the substrate, a bottom recess of the first elastomer layer bearing a first recess;

a second elastomer layer overlying the first elastomer layer, a bottom surface of the second elastomer bearing a second recess; and

a third elastomer layer overlying the second elastomer layer, a bottom surface of the third elastomer layer bearing a third recess,

such that a first deflectable membrane is defined from a portion of the first elastomer layer between the first recess and the second recess, and a second deflectable membrane is defined from a portion of the second elastomer layer between the second recess and the third recess.

6. The structure of claim 5 wherein:

the second recess comprises a flow channel; and

the first and third recesses comprise control channels for deflecting the first and second membranes into the flow channel to control a flow of material through the flow channel.

7. The structure of claim 6 wherein the first and third recesses are aligned to one another, such that deflection of the first and second membranes causes the first and second membranes to meet in the flow channel.

8. The structure of claim 6 wherein the first and third recesses are positioned orthogonal relative to one another, wherein a crossover of second control channel, the flow channel, and the first control control channel defines a valve comprising the first membrane and the second membrane deflectable to meet in the flow channel.

9. The structure of claim 6 wherein:

the second recess comprises a first series of parallel flow channels intersecting with a perpendicularly-oriented second series of parallel flow channels to form an array of flow junctions;

the first recess comprises,

a first series of control channels overlapped by the first series of flow channels to form a first set of valves adjacent to the flow junctions, and

a second series of control channels overlapped by the second series of flow channels to form a second set of valves adjacent to the flow junctions; and

the third recess comprises,

a third series of control channels overlapping the first series of flow channels to form a third set of valves adjacent to the flow junctions, and

a fourth series of control channels overlapping the second series of flow channels to form a fourth set of valves adjacent to the flow junctions,

such that the first, second, third, and fourth valve sets are independently operable to control movement of material into the flow junctions.

10. The structure of claim 5 wherein:

the first recess comprises a flow channel;

the second recess comprises a first control channel for actuating the first membrane to control a flow of material through the flow channel; and

the third recess comprises a second control channel for actuating the second membrane to control the functioning of the first control channel.

11. The structure of claim 10 wherein:

the flow channel comprises a series of functional blocks; and

the first control channel comprises a plurality of branches in communication with the functional blocks, such that actuation of the second control channel selectively prevents branches of the first control channel from communicating with the functional blocks.

12. A method of forming a via in a microfabricated elastomer structure comprising:

placing an elastomer material in contact with a mold comprising raised features;

curing the elastomer material;

removing the cured elastomer material from the mold

puncturing the cured elastomer material with a rigid hollow member; and

removing the rigid hollow member from the cured elastomer material to reveal a first via opening in fluid communication with the first recess.

13. The method of claim 12 wherein the cured elastomer material is punctured by the rigid hollow member at a recess corresponding to a location of the raised mold feature, thereby ensuring alignment of the via with the recess.

14. The method of claim 12 further comprising:

placing the cured, punctured elastomer material onto a top surface of a second cured elastomer material bearing a second recess corresponding to a location of raised features of a second mold structure; and

puncturing the second cured elastomer material and the first cured elastomer material at the second recess; and

removing the rigid hollow member to reveal a second via in fluid communication with the second recess.

15. The method of claim 12 further comprising:

placing the cured and punctured elastomer layers onto a top surface of an additional cured elastomer layer bearing a further recess corresponding to a location of raised features of a further mold structure; and

puncturing the additional cured elastomer layer and the cured and punctured elastomer layers at the further recess; and

removing the rigid hollow member to reveal an additional via in fluid communication with the further recess.

16. A microfluidic structure comprising:

an underlying substrate;

a first elastomer layer overlying the substrate, the first elastomer layer bearing in a bottom surface a first recess, the first recess patterned in a plurality of channels splitting into a plurality of parallel branches, the parallel branches reuniting; and

a second elastomer layer overlying the first elastomer layer, the second elastomer layer bearing in a bottom surface a second recess, the second recess patterned in a plurality of parallel channels oriented orthogonal to the parallel branches; and

membrane portions of the first elastomer layer defined between a widened portion of the parallel channels and the underlying parallel branches, the membrane portions deflectable into the parallel branches to control a flow of fluid through the parallel branches.